CLAIMS

1. A method of bi-ventricular, fusion-pacing therapy delivery to a non-synchronous pair of ventricles, including delivery of a single ventricular pre-excitation pacing pulse to a relatively late activated ventricular chamber to promote mechanical synchrony between the late activated ventricular chamber and a relatively more rapid, intrinsically conducting ventricular chamber, comprising:

measuring an intrinsic atrio-ventricular delay interval for a first-to-depolarize ventricular (V1) chamber for at least one prior cardiac cycle; and

delivering during a subsequent cardiac cycle at least one ventricular pre-excitation pacing pulse to a second-to-depolarize ventricular (V2) chamber, wherein said at least one ventricular pre-excitation pacing pulse is delivered at the expiration of a V2 pacing interval, wherein the V2 pacing interval is temporally shorter than the intrinsic atrio-ventricular delay interval of the V1 chamber.

2. A method according to claim 1, wherein the step of measuring the intrinsic atrio-ventricular (AV) delay interval further comprises at least one of:

calculating an average AV delay interval,

calculating a weighted average AV delay,

measuring a prior intrinsic AV delay interval,

looking up an AV delay interval correlated to a heart rate,

looking up an AV delay interval correlated to an activity sensor input,

looking up an AV delay interval correlated to a minute respiration value,

looking up an AV delay interval correlated to a fluid pressure signal,

looking up an AV delay interval correlated to an acceleration signal.

3. A method according to claim 1, wherein the first-to-depolarize ventricular chamber (V1) comprises a right ventricle.

4. A method according to claim 1, wherein said at least one ventricular pre-excitation pacing pulse is delivered via at least one electrode adapted to be coupled to a left ventricular chamber.

5. A method according to claim 4, wherein the left ventricular chamber comprises a portion of one of:

a coronary sinus,

a portion of a great vein,

a portion of a vessel branching from the great vein.

6. A method according to claim 1, wherein said at least one ventricular pre-excitation pacing pulse is delivered between a tip and a ring pacing electrode, a pair of electrodes, a coil and a can-based electrode, a pair of coil electrodes, an epicardial electrode and a second electrode, or a subcutaneous electrode and the second electrode.

7. A method according to claim 1, wherein the measuring step occurs between at least one of:

a tip and a ring pacing electrode,

a pair of electrodes,

a coil and a can-based electrode,

a pair of coil electrodes,

an epicardial electrode and a second electrode,

a subcutaneous electrode and the second electrode.

8. A method according to claim 7, wherein at least one of said electrode(s) is adapted to couple to an anterior portion of the left ventricle.

9. A method according to claim 1, wherein said at least one ventricular pre-excitation pacing pulse is delivered with at least one electrode adapted to couple epicardially to the V2 chamber.

10. A method according to claim 1, wherein the subsequent cardiac cycle comprises an immediately subsequent cardiac cycle.

11. A method according to claim 1, wherein the at least one prior cardiac cycle comprises an immediately prior cardiac cycle.

12. A method according to claim 1, wherein the at least one prior cardiac cycle comprises at least three consecutive, immediately prior, cardiac cycles.

13. A method according to claim 12, wherein the most recent of the at least three consecutive, immediately prior, cardiac cycles is mathematically weighted more heavily than the other said cardiac cycles.

14. A method according to claim 1, further comprising:

monitoring a physiologic cardiac parameter of a patient during delivery of the fusion-based cardiac pacing regimen.

15. A method according to claim 14, further comprising:

comparing the physiologic parameter to a threshold value; and

based on the results of the comparison, performing one of:

a. ceasing delivery of the fusion-based cardiac pacing regimen,

b. applying a bi-ventricular pacing regimen on a beat-by-beat basis,

c. decrementing the V2 interval.

16. A method according to claim 11, wherein the pre-excitation interval comprises a discrete interval of a plurality of discrete intervals and said plurality of intervals are correlated to an output signal that is in turn correlated to a physiologic parameter, and further comprising:

monitoring the output signal; and

delivering at least one ventricular pre-excitation pacing pulse at the expiration of the discrete interval.

17. A method according to claim 16, wherein the output signal comprises at least one of: a heart rate output signal, a cardiac pressure output signal, a minute ventilation output signal, an activity sensor output signal, an acceleration output signal.

18. A method according to claim 17, wherein the plurality of discrete intervals are stored as a data set and wherein each discrete interval of the data set corresponds to a magnitude of the output signal.

19. An apparatus for delivering bi-ventricular, fusion-pacing therapy to one of a non-synchronous pair of ventricles, to promote mechanical synchrony between an intrinsically first-to-depolarize ventricular chamber and an intrinsically second-to-depolarize, ventricular chamber, comprising:

means for measuring an intrinsic atrio-ventricular delay interval for a first-to-depolarize ventricular (V1) chamber for at least one prior cardiac cycle; and

means for delivering during a subsequent cardiac cycle at least one ventricular pre-excitation pacing pulse to a second-to-depolarize ventricular (V2) chamber, wherein said at least one ventricular pre-excitation pacing pulse is delivered at the expiration of a V2 pacing interval, wherein the V2 pacing interval is temporally shorter than the intrinsic atrio-ventricular delay interval of the V1 chamber.

20. A method according to claim 19, wherein the means for measuring the intrinsic atrio-ventricular (AV) delay interval further comprises at least one of the following:

means for calculating an average AV delay interval,

means for calculating a weighted average AV delay,

means for measuring a prior intrinsic AV delay interval,

means for looking up an AV delay interval correlated to a heart rate,

means for looking up an AV delay interval correlated to an activity sensor input,

means for looking up an AV delay interval correlated to a minute respiration value,

means for looking up an AV delay interval correlated to a fluid pressure signal,

means for looking up an AV delay interval correlated to an acceleration signal.

21. An apparatus according to claim 19, wherein the V1 chamber comprises a right ventricle.

22. An apparatus according to claim 19, wherein said at least one ventricular pre-excitation pacing pulse is delivered via at least one electrode adapted to be coupled to a left ventricular chamber, which comprises the V2 chamber.

23. An apparatus according to claim 22, wherein the left ventricular chamber comprises a portion of one of:

a coronary sinus,

a portion of a great vein,

a portion of a vessel branching from the great vein.

24. An apparatus according to claim 19, wherein said at least one ventricular pre-excitation pacing pulse is delivered between:

a tip and a ring pacing electrode, a pair of electrodes, a coil and a can-based electrode, a pair of coil electrodes, an epicardial electrode and a second electrode, or a subcutaneous electrode and the second electrode.

25. An apparatus according to claim 19, wherein the means for measuring comprises at least one of:

a tip and a ring pacing electrode,

a pair of electrodes,

a coil and a can-based electrode,

a pair of coil electrodes,

an epicardial electrode and a second electrode,

a subcutaneous electrode and the second electrode.

26. An apparatus according to claim 25, wherein at least one of said electrode(s) is adapted to couple to an anterior portion of the left ventricle.

27. An apparatus according to claim 19, wherein said at least one ventricular pre-excitation pacing pulse is delivered with at least one electrode adapted to couple epicardially to the second-to-depolarize ventricular chamber.

28. An apparatus according to claim 19, wherein the subsequent cardiac cycle comprises an immediately subsequent cardiac cycle.

29. An apparatus according to claim 19, wherein the at least one prior cardiac cycle comprises an immediately prior cardiac cycle.

30. An apparatus according to claim 19, wherein the at least one prior cardiac cycle comprises at least three consecutive, immediately prior, cardiac cycles.

31. An apparatus according to claim 30, wherein the most recent of the at least three consecutive, immediately prior, cardiac cycles is mathematically weighted more heavily than the other said cardiac cycles.

32. An apparatus according to claim 19, further comprising:

means for monitoring a physiologic cardiac parameter of a patient during delivery of the fusion-based cardiac pacing regimen.

33. An apparatus according to claim 32, further comprising:

means for comparing the physiologic parameter to a threshold value; and

at least one of:

a. means for ceasing delivery of the fusion-based cardiac pacing regimen,

b. means for applying a bi-ventricular pacing regimen on a beat-by-beat basis,

c. means for decrementing the V2 pacing interval.

34. An apparatus according to claim 29, wherein the pre-excitation interval comprises a discrete interval among a plurality of discrete intervals and said plurality of intervals are correlated to a heart rate, and further comprising:

means for monitoring the heart rate of a patient; and

means for delivering at least one ventricular pre-excitation pacing pulse at the expiration of the discrete interval.

35. An apparatus according to claim 34, wherein the heart rate comprises a range of heart rates.

36. An apparatus according to claim 35, wherein the plurality of discrete intervals are stored as a data set and wherein each discrete interval corresponds to a range of heart rates.

37. A computer readable medium for storing instructions for delivering bi-ventricular, fusion-pacing therapy to one of a non-synchronous pair of ventricles, to promote mechanical synchrony between an intrinsically first-to-depolarize ventricular chamber and an intrinsically second-to-depolarize, ventricular chamber, comprising:

instructions for measuring an intrinsic atrio-ventricular delay interval for a first-to-depolarize ventricular (V1) chamber for at least one prior cardiac cycle; and

instructions for delivering during a subsequent cardiac cycle at least one ventricular pre-excitation pacing pulse to a second-to-depolarize ventricular (V2) chamber, wherein said at least one ventricular pre-excitation pacing pulse is delivered at the expiration of a V2 pacing interval, wherein the V2 pacing interval is temporally shorter than the intrinsic atrio-ventricular delay interval of the V1 chamber.

38. A medium according to claim 37, wherein the instructions for measuring the intrinsic atrio-ventricular (AV) delay interval further comprises at least one of the following:

instructions for calculating an average AV delay interval,

instructions for calculating a weighted average AV delay,

instructions for measuring a prior intrinsic AV delay interval,

instructions for looking up an AV delay interval correlated to a heart rate,

instructions for looking up an AV delay interval correlated to an activity sensor input,

instructions for looking up an AV delay interval correlated to a minute respiration value,

instructions for looking up an AV delay interval correlated to a fluid pressure signal,

instructions for looking up an AV delay interval correlated to an acceleration signal.

39. A medium according to claim 37, wherein the V1 chamber comprises a right ventricle.

40. A medium according to claim 37, wherein said at least one ventricular pre-excitation pacing pulse is delivered via at least one electrode adapted to be coupled to a left ventricular chamber.

41. A medium according to claim 40, wherein the left ventricular chamber comprises a portion of one of:

a coronary sinus,

a portion of a great vein,

a portion of a vessel branching from the great vein.

42. A medium according to claim 37, wherein said at least one ventricular pre-excitation pacing pulse is delivered between:

a tip and a ring pacing electrode, a pair of electrodes, a coil and a can-based electrode, a pair of coil electrodes, an epicardial electrode and a second electrode, or a subcutaneous electrode and the second electrode.

43. A medium according to claim 37, wherein the instructions for measuring comprises at least one of:

a tip and a ring pacing electrode,

a pair of electrodes,

a coil and a can-based electrode,

a pair of coil electrodes,

an epicardial electrode and a second electrode,

a subcutaneous electrode and the second electrode.

44. A medium according to claim 43, wherein at least one of said electrode(s) is adapted to couple to an anterior portion of the left ventricle.

45. A medium according to claim 37, wherein said at least one ventricular pre-excitation pacing pulse is delivered with at least one electrode adapted to couple epicardially to the V2 chamber.

46. A medium according to claim 37, wherein the subsequent cardiac cycle comprises an immediately subsequent cardiac cycle.

47. A medium according to claim 37, wherein the at least one prior cardiac cycle comprises an immediately prior cardiac cycle.

48. A medium according to claim 37, wherein the at least one prior cardiac cycle comprises at least three consecutive, immediately prior, cardiac cycles.

49. A medium according to claim 48, wherein the most recent of the at least three consecutive, immediately prior, cardiac cycles is mathematically weighted more heavily than the other said cardiac cycles.

50. A medium according to claim 37, further comprising:

instructions for monitoring a physiologic cardiac parameter of a patient during delivery of the fusion-based cardiac pacing regimen.

51. A medium according to claim 50, further comprising:

instructions for comparing the physiologic parameter to a threshold value; and at least one of:

a. instructions for ceasing delivery of the fusion-based cardiac pacing regimen,

b. instructions for applying a bi-ventricular pacing regimen on a beat-by-beat basis,

c. instructions for decrementing the V2 pacing interval.